

---

# **APPENDIX II**

Daimler Chrysler Inc.

**Summary ABSTRACT OF THE DISCLOSURE**

This invention involves an An internal combustion engine for a motor vehicle, with a lubricant pump to transport a fluid, almost incompressible lubricant, especially a motor oil, as well as with a lubricant guide element (1b) to guide the lubricant to the lubrication points of the internal combustion engine. In the internal combustion engine, of the invention has an elastic, flexible dampening element (2b) to accept pressure pulsations in the lubricant is associated with the lubricant guide element (1b). A dampening element (2b), for example, can have a bypass resonator with a calmed lubricant reservoir (4b).

Use, for example, is in passenger motor vehicles.

Figure 2

---

# **APPENDIX III**

Daimler Chrysler Inc.

Internal Combustion Engine with a Lubrication Circuit  
And a Dampening Element INTERNAL COMBUSTION ENGINE COMPRISING A  
LUBRICANT CIRCUIT AND A DAMPING ELEMENT

---

BACKGROUND AND SUMMARY OF THE INVENTION

[0001] This invention involves an internal combustion engine for a motor vehicle with a lubricant pump to transport a fluid, almost incompressible lubricant, especially a motor oil, as well as a lubricant guide element to guide the lubricant to the lubrication points of the internal combustion engine.

[0002] It is ~~the goal~~ an object of the invention to make available an internal combustion engine for a motor vehicle in which pressure pulsations are damped within a lubricant guide element and sound radiations are effectively reduced.

[0003] ~~The goal~~ This object is achieved by an internal combustion engine according to Claim 1 as claimed. Advantageous variations and further developments of the invention are ~~the objects of Sub claims 2 to 9 also claimed~~.

[0004] The ~~internal combustion engine for a motor vehicle manifests a lubricant pump to transport a fluid, almost incompressible lubricant, especially a motor oil, as well as a lubricant guide element to guide a lubricant to the lubrication points of the internal combustion engine.~~ According to the invention, an elastic, flexible, dampening element to accept pressure pulsations in the lubricant is associated with the lubrication guide element in the internal combustion engine. The dampening element preferably is a component part guiding the lubricant and thus is ~~so~~ coupled in the lubrication circuit so that it is in direct contact with the lubricant. Natural or synthetic oils are preferably used as the lubricant. The dampening element manifests a flexibility in the lubrication circuit, which preferably includes a dead water zone, ~~or~~ a resonance area, or a flexible wall. Pressure pulsations of the lubricant can ~~thereby~~ be reduced by friction and turbulence or, as the case may be, by specific discharge into the wall.

[0005] In ~~the design one embodiment~~ of the invention, the dampening element manifests an abrupt expansion of the line cross-section, ~~especially~~ in the manner of a bypass resonator, to form a calmed lubricant reservoir. A dead water zone, ~~is formed in the calmed lubricant reservoir~~ in which pressure pulsations of the lubricants can be reduced, is formed in the calmed lubricant reservoir. The expansion of the line cross-

section can be designed ~~in particular~~ as a Helmholtz resonator, across which specifically determined oscillation frequencies from the lubrication circuit can be sent.

[0006] In another ~~variation~~ embodiment of the invention, the dampening element manifests a flexible membrane to limit the lubricant reservoir and/or the lubricant guide element. The membrane preferably ~~manifests~~ has a higher elasticity than the other lubricant guide components of the internal combustion engine. For that reason, the membrane is preferably constructed of an elastic material or component, especially and preferably of a lubricant-resistant plastic. Alternatively, the membrane ~~is~~ can be constructed as an especially thin-walled component. The membrane can be housed with lubricant on one side and ambient air on the other side or, as the case may be, in a closed storage volume, ~~and~~ is preferably impacted with under pressure of an inert gas.

[0007] In another ~~version~~ embodiment of the invention, the dampening element ~~manifests~~ has a storage volume to accept a compressible medium, ~~especially to accept~~ such as a quantity of gas and/or a foam. The storage volume is preferably separate from the lubrication circuit, but is constructed directly adjacent to it. For the separation, a flexible membrane is associated with the gas quantity or a largely closed separating layer with the foam, especially in the form of closed pores. ~~In the process,~~ The The gas quantity or the foam manifests a higher compressibility than the lubricant.

[0008] In another ~~variation~~ embodiment of the invention, the dampening element ~~manifests~~ includes a storage volume to ~~accept~~ receive a rubber-elastic body. The rubber-elastic body possesses a higher compressibility than the lubricant, and acts as an especially effective damper for the pressure pulsations that appear. The rubber-elastic body ~~can~~ is preferably be constructed as a pipe guide element ~~flowed through by~~ which the lubricant flows.

[0009] In another ~~model~~ embodiment of the invention, the dampening element ~~manifests~~ has a storage volume to accept a mixture of the lubricant and a compressible medium, ~~in particular such as~~ a quantity of gas. The lubricant and the compressible medium are not separated in the storage volume, ~~whereby~~ and the degree of intermixing is variable. The intermixing can almost be zero, especially with an internal combustion engine that is not ~~operating~~, i.e., a operating, so that a horizontal, free surface of the lubricant lies opposite the compressible medium. ~~There can also,~~ ~~however,~~ be a A suspension or a largely homogeneous mixture of the lubricant and the compressible medium can also be used, however. Another practical, especially ~~relevant~~ ease ~~is an~~ advantageous configuration provides expansion of the lubricant with a compressible medium in the form of air, ~~whereby~~ with the degree of expansion preferably ~~is so set, that~~ set so that the lubricating effect of the lubricant at ~~the~~

lubrication spots locations of the internal combustion machine is not disadvantageously affected.

[0010] In another variation embodiment of the invention, the elasticity of the membrane, the compressible medium, and/or the rubber-elastic body can be changed or adjusted. That is done ~~in particular~~ by way of a change ~~of~~ in pressure, temperature, and/or the volume of the membrane, the compressible medium, or the rubber-elastic body. To influence the temperature of the membrane, the compressible medium, or the rubber-elastic body, an electrical resistance heating, for example, can be used.

[0011] In another version embodiment of the invention, the quantity of the compressible medium accepted in the storage volume can be changed by the addition and/or removal of the compressible medium via an input opening. ~~In the process, the~~ The elasticity of the dampening element can be adjusted by a change of the compressible medium in the dampening element. The degree of expansion can thus also be influenced ~~in particular~~ in a case involving expansion of the lubricant with the help of the compressible medium.

[0012] In another execution model embodiment of the invention, the dampening element is coupled across a line rising in a vertical direction to a lubricant guide

element, so that element. In this way, a compressible medium, such as a quantity of gas, is blocked in a storage volume inside a dampening element, in particular a gas quantity, with element with the help of the lubricant. Air is preferably used as the compressible medium which can be housed in an especially simple manner in the sealed dampening element.

[0013] Other characteristics and combinations of characteristics can be seen in are apparent from the description and the drawings. Concrete execution models embodiments of the invention are depicted in a simplified manner in the drawings and are explained in more detail in the following description. Shown are:

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0014] Figure 1: A 1 is a sketch of the principle of a lubricant guide element with an initial variant a first embodiment of a dampening element of the invention;

[0015] Figure 2: A 2 is a sketch of the principle of a lubricant guide element with a second variation embodiment of a dampening element of the invention;

[0016] Figure 3: A 3 is a sketch of the principle of a lubricant guide element with a third variant embodiment of a dampening element of the invention;

[0017] Figure 4:A 4 is a sketch of the principle of a lubricant guide element with a fourth ~~version~~ embodiment of a dampening element of the invention;

[0018] Figure 5:A 5 is a sketch of the principle of a lubricant guide element with a fifth ~~model~~ embodiment of a dampening element of the invention;

[0019] Figure 6:A 6 is a sketch of the principle of a lubricant guide element with a sixth ~~variant~~ embodiment of a dampening element of the invention;

[0020] Figure 7:A 7 is a sketch of the principle of a lubricant guide element with a seventh ~~variant~~ embodiment of a dampening element of the invention;

[0021] Figure 8:A 8 is a sketch of the principle of a lubricant guide element with an eighth ~~version~~ embodiment of a dampening element of the invention;

[0022] Figure 9:A 9 is a sketch of the principle of a lubricant guide element with a ninth ~~variant~~ embodiment of a dampening element of the invention;

[0023] Figure 10: A 10 is a sketch of the principle of a lubricant guide element with a tenth variant embodiment of a dampening element of the invention; and

[0024] Figure 11: A 11 is a sketch of the principle of a lubricant guide element with an eleventh version embodiment of a dampening element of the invention.

#### DETAILED DESCRIPTION OF THE INVENTION

[0025] An internal combustion engine manifests has, in a known manner, a lubrication circuit in which a lubricant pump moves a fluid lubricant, in particular a natural or synthetic motor oil, from a lubricant storage reservoir to lubrication spots points or locations of the internal combustion engine and, as the case may be, back to the storage reservoir. In the process, the lubricant flows in general both through several lubrication guide elements on the one hand, as well as and a housing of the internal combustion engine. The lubrication pump is thereby associated with a lubrication guide element in the shape of a suction pipe line through which the lubricant moves from the storage reservoir (e.g., oil pump) to a lubricant pump.

[0026] During the operation of an internal combustion engine, the lubricant pump is generally also powered across a transmission by a gear of the internal combustion engine, whereby a engine. A pulsating movement of the lubricant is

caused by ~~the operating principle~~ operation of the lubricant pump (e.g. geared wheel pump). The resulting pressure pulsations cause a (mostly unwanted) sound production, transmission, and radiation.

[0027] To offset the ~~named~~ pressure pulsations mentioned, a flexible dampening element ~~is provided in the invention, which is~~ associated with a lubrication guide element of the lubrication circuit is provided according to the invention.

[0028] ~~An initial sketch of the principle of a~~ A lubrication guide element 1a is shown in Figure 1 with ~~an initial execution model~~ a first embodiment of a dampening element 2a of the invention. The lubricant guide element 1a is constructed as an almost vertically positioned suction line of a lubricant pump, which is not shown in more detail. The dampening element 2a thereby manifests an abrupt expansion 3a of the line cross-section of the suction line to form a calmed area 4a. The calmed area includes a certain length of the suction line and ends with an abrupt narrowing 3a'. The dampening element 2a is filled completely with the lubricant, whereby dead water areas that are present form a calmed lubricant reservoir to dampen the pressure pulsations. The lubricant guide element 1a as well as the dampening element 2a can be manifested as have a round or a non-round, rectangular cross-sectional area, whereby although rectangular cross-sectional areas favor the dampening of pressure

pulsations in an advantageous manner. That This also applies to the other ~~execution models~~ embodiments.

[0029] Figure 2 shows a ~~second sketch of the principle of a lubrication guide element 1b with a second execution model embodiment~~ of a dampening element 2b of the invention. The dampening element 2b is constructed as a type of bypass resonator, whereby this is resonator connected with the lubricant guide element 1b across a bleed line 6 (resonator throat) running perpendicular to the lubricant guide element 1b and is completely filled with lubricant. An abrupt expansion 3b of the cross-section of the bleed line 6 is provided to form a calmed lubricant reservoir 4b.

[0030] Figure 3 shows a ~~third sketch of the principle of a lubrication guide element 1c with a third execution model embodiment~~ of a dampening element 2c of the invention. There is an abrupt expansion 3c of the cross-section of the bleed line 6 to form a calmed lubricant reservoir 4c. The dampening element according to Figure 3 differs from the version of Figure 2 only by the in that a flexible, elastic membrane 5 ~~on forms~~ the wall of the dampening element lying opposite the bleed line 6. In particular, the inside of the membrane 5 is in contact with the lubricant. In the process, it thereby preferably manifests a higher elasticity than most other component elements of the lubricant circuit of the internal combustion engine, so that pressure pulsations can

preferably be guided into the membrane area. The dampening element 2c is so positioned, that positioned that the outside of the membrane is surrounded by ambient air or another compressible medium. In a modified ~~execution model embodiment~~, the membrane is likewise surrounded on the outside by lubricant, which preferably can be done accomplished by housing the dampening element being housed in the lubricant storage reservoir of the internal combustion engine.

[0031] Figure 4 shows a fourth sketch of the principle of a lubrication guide element 1d with a fourth ~~execution model embodiment~~ of a dampening element 2d of the invention. There is an abrupt expansion 3d of the cross-section of the bleed line 6 to form a calmed lubricant reservoir 4d. The dampening element 2d according to Figure 4 differs from the versions of Figures 2 and 3 by in that the dampening element 2d has a storage volume 7 that is closed on all sides to accept a defined quantity of gas G. The storage volume 7 ~~manifests has~~ a flexible, elastic membrane 8 and is otherwise constructed with a bowl or pot shape. Pressure pulsations are guided in an advantageous manner specifically across the membrane 8 into the storage volume 7. In a modified ~~execution model embodiment~~, the storage volume 7 and/or the membrane 8 are constructed so as to be heated by means of electrical resistance heating to adjust the elasticity.

[0032] Figure 5 shows a ~~fifth sketch of the principle of a~~ lubrication guide element 1e with a ~~fifth execution model embodiment~~ of a dampening element 2e of the invention. An abrupt expansion 3e of the cross-section of the bleed line 6 is provided to form a calmed lubricant reservoir 4e. The dampening element 2e according to Figure 5 differs from that of Figure 2 and 3 by ~~the in that the~~ dampening element 2e has a membrane 9 which divides the lubricant reservoir 4e into two partial volumes preferably of the same size.

[0033] Figure 6 shows a ~~sixth sketch of the principle of a~~ lubrication guide element 1f with a ~~sixth execution model embodiment~~ of a dampening element 2f of the invention. There is an abrupt expansion 3f of the cross-section of the bleed line 6 to form a calmed lubricant reservoir 4f. The dampening element 2f according to Figure 6 differs from the models of Figures 2 and 4 by a storage volume 10 to accept a rubber-elastic shaped body. The shaped body is constructed in a modified execution model to adjust the elasticity by means of electrical resistance heating.

[0034] Figure 7 shows a ~~seventh sketch of the principle of a~~ lubrication guide element 1g with a ~~seventh execution model embodiment~~ of a dampening element 2g of the invention. There is an abrupt expansion 3g of the cross-section of the lubricant guide element 1g to form a calmed area 4g. The calmed area 4g includes a certain long

area of a suction line and ends with an abrupt narrowing 3g'. The dampening element 2g is completely filled with lubricant, whereby and the dead water areas present form a calmed lubricant reservoir to dampen the pressure pulsations. Finally a rubber-elastic wall 11 is associated with the dampening element 2g which forms the boundary of the lubricant-guiding interior area. The dampening element 2g is thus designed as a type of normal line element, but compared to the other line elements it manifests an increased compressibility which is designed so that pressure pulsations – especially in the selected frequency ranges – are accepted well and are damped. The rubber-elastic wall 11 is preferably stiffened with metal on the outside.

[0035] Figure 8 shows ~~an eighth sketch of the principle of a lubrication guide element 1h with an eighth execution model embodiment~~ of a dampening element 2h of the invention. ~~As a difference to the~~ The eighth embodiment differs from the seventh execution model embodiment according to Figure 7 in that there is no expansion of the cross-section of the lubricant guide element; instead, a lubricant-guiding, rubber-elastic, cylindrical-shaped part 12 is provided which provided. The part 12 is designed in such a compressible manner that pressure pulsations – especially in the selected frequency ranges – are accepted well and are damped. The rubber-elastic, cylindrical-shaped part 12 is preferably stiffened or encased with metal on the exterior. The length and thickness of the shaped part are selected depending on the frequency

range of the pressure pulsations to be damped. In a modified ~~execution model embodiment~~, a dampening element according to Figure 8 substitutes a complete suction line of a lubricant pump.

[0036] Figure 9 shows a ~~ninth sketch of the principle of a~~ lubrication guide element 1j with a ~~ninth execution model embodiment~~ of a dampening element 2j of the invention. The dampening element 2j is constructed like a bypass resonator, ~~whereby this and~~ is connected with the lubricant guide element 1j across a bleed line 6 (resonator throat) running perpendicular to the lubricant guide element 1j. An abrupt expansion 3j of the cross-section of the bleed line 6 is provided to form a calmed lubricant reservoir 4j. In addition, a branch boring 13 is positioned on the top of a vertical side of the dampening element ~~2j through which a~~ ~~2j~~. A compressible medium, preferably air, can be introduced to or removed from the lubricant reservoir 4j through the branch boring. Thus, the mass of the air in the reservoir can be varied, by means of the branch boring 13, so that the elasticity of the dampening elements 2j can be adjusted. The lubricant and air are not separated in the lubricant reservoir 4j so that both can mix, ~~whereby and~~ the degree of mixing is variable. The mixing can be almost zero for a non-operating internal combustion engine, i.e., a free, horizontal surface 14 of the lubricant is exposed to the air. A strong expansion of the lubricant with the air can, however, be produced in the area of the lubricant reservoir 4j, ~~whereby so that~~ the

entire reservoir 4j can be filled by the expanded mixture of the lubricant and air. The degree of expansion is preferably regulated so that the lubrication effect of the lubricant is not disadvantageously affected at the lubrication ~~spots~~ lubrications of the internal combustion engine. Thus, an optimal relationship between the dampening effect on the dampening element 2j and the lubrication effect at the lubrication ~~spots~~ locations of the internal combustion engine can be set by means of the degree of expansion. In addition, an especially high dampening effect against pressure pulsations in the lubricant can be obtained, when needed.

[0037] Figure 10 shows a ~~tenth sketch of the principle of a~~ lubrication guide element 1k with a ~~tenth execution model~~ embodiment of a dampening element 2k of the invention. The dampening element 2k is constructed as a type of bypass resonator, ~~whereby this which~~ is connected with the lubricant guide element 1k across a bleed line 6 rising in a vertical direction running perpendicular to a lubricant guide element 1b. There is an abrupt expansion 3k of the cross-section of the bleed line 6 to form a calmed lubricant reservoir 4k. The lubricant reservoir 4k is only partially filled with the lubricant; the other part is filled with a compressible medium, preferably with air or with an inert gas which is confined above the fluid level 15 of the lubricant ~~quasi~~ in the lubricant reservoir 4k and can not be forced out of the reservoir. In a modified

~~execution model embodiment~~, the reservoir is completely filled, preferably with an inert gas.

[0038] Figure 11 shows ~~an eleventh sketch of the principle of a lubrication guide element 1m with an eleventh execution model embodiment~~ of a dampening element 2m of the invention. The dampening element 2m is constructed as a type of gas or air pillow and is placed on the base of the lubricant reservoir which is constructed in the shape of an oil sump ~~(16)~~ 16. In particular, the dampening element 2m is coupled to the lubrication circuit ~~in so~~ that it is positioned at a slight distance next to – preferably opposite – the intake suction opening of the lubricant guide element 1m. An elastic membrane 17 is provided on the side of the dampening element 2m facing the intake suction opening.

[0039] In all of the ~~execution models~~ embodiments depicted, a coupling of the compressible element (dampening element) to the lubrication circuit of a vehicle internal combustion engine is done in such a way that pressure pulsations are guided into the compressible element and are damped there or can be guided out of the lubrication circuit. As a result, the sound radiation of the entire internal combustion engine is reduced ~~in by way of~~ the invention.

[0040] The characteristics of the ~~execution models~~ embodiments of the device of the invention which were described as examples can be combined with each other in any desired manner, so that other advantageous properties and ~~combination~~ combinations of properties can result.

---

---